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ABSTRACT

The effectiveness of the simulation-gaming method of instruction as opposed to the lecture-discussion method in teaching a college introductory economics course is examined. One hundred and twenty Ashland College freshmen were tested to determine their knowledge, interest, and training in economics; retention of knowledge seven weeks after the course; and scholastic abilities. Students were randomly assigned to one of the two types of courses. Using the lecture-discussion technique as the control method, two tests (the hybrid version of the Test of Understanding in College Economics and the Questionnaire of Student Attitudes Toward Economics) were used to measure the impact of the two methods of instruction. Tests were given pre-course, post-course, and seven weeks later. Four additional data were also analyzed: level of high school training, Scholastic Aptitude Test (SAT) score, college course instruction method, and the instructor to whom the student was exposed. Findings showed that students with low pre-course knowledge, no previous economic training, and low SAT scores achieved a higher level of post-course economic knowledge and retention when instructed by the simulation-gaming method. The obverse is true for the lecture-discussion method. While neither method could be labelled superior, the relative effectiveness of each was dependent on certain student characteristics. When advising or assigning students to introductory economics courses, college instructors should be aware of these findings. (CK)

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The Effectiveness of a Simulation-Gaming Method of Instruction for Teaching College Level Introductory Economics

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Paper presented at the Annual Meeting of The Eastern Economic Association, May 10-12, 1979 Boston, Massachusetts

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It was clear from a review of the literature that additional research with greater research controls was needed to support or refute the advantage of using the simulation-gaming technique in an introductory economics course. Such research would enable educators to draw more accurate conclusions concerning the effectiveness of the simulation-gaming technique for teaching such courses.

This study was an attempt to utilize a strong research design to investigate the effectiveness of a simulation-gaming method of instruction to teach a college level introductory course. More specifically the two primary questions investigated in the study were: (a) Is the simulation-gaming technique superior to the lecture discussion technique in increasing the economic knowledge, interests in economics, and retention of economic knowledge of the college students enrolled in an introductory economics course? (b) Do the instructors and the students' pre-course economic knowledge, scholastic abilities, pre-course interests in economics, and previous economic training influence the relative effectiveness of the two methods of instruction to increase the students' economic knowledge, retention of economic knowledge, and interests in economics?

Design of the Study and Data Collection

The Ashland College Freshman students of the 1977-1978 academic year who declared an intent to major or minor in business administration or economics were defined as the population for this study. A total of 172 freshman students had indicated on pre-registration forms their intent to major or minor in business administration or economics. One hundred twenty of these 172 students were randomly sampled. Each of the 120

students were randomly assigned to one of the four course sections used in the study. The students in two of the course sections were exposed to the simulation-gaming method of instruction. The students in the other two sections were exposed to the lecture-discussion method of instruction. The students were heterogeneous with respect to their pre-course economic knowledge, pre-course interests in economics, scholastic abilities, and previous economic training. The results of t-tests and chi-square tests, however, indicated there was no statistically significant differences at the two-tailed criteria level of .05 between the simulation-gaming sections and the lecture-discussion sections with respect to these student characteristics. Further analysis indicated that research mortality that occurred during the study did not affect the homogeneity of the course sections with respect to the four student characteristics.

Two instructors were chosen to be the instructors for the four course sections. Each instructor was randomly assigned to a simulation-gaming section and a lecture-discussion section of the introductory economics course. The introductory course was a one semester economics course that included both microeconomic and macroeconomic concepts.

The basic feature of the lecture-discussion technique, which was the method of instruction utilized in the control groups, was the instructor's lectures. Student questions and comments were, however, encouraged. This lecture-discussion technique was designated as the

control method because it was the most frequently used method of instruction in the Economics Department at Ashland College.

The simulation-gaming technique, which was the method of instruction used in the experimental groups, integrated simulation games and simulations with the lecture-discussion method of instruction. A total of 18-1/3 class periods were either devoted to playing the simulations or simulation games or spent in debriefing sessions. Thus, approximately 50 percent of the 37 class periods used for instruction were devoted to the simulations and simulation games. The seven simulation activities that were used in the simulation-gaming technique and the order in which they were used were as follows: (a) Outdoor-Endurance [11] (b) Starting a Small Business: A Simulation Game [4] (c) The Multiplier [13] (d) Mr. Banker [9] (e) Tightrope [5] (f) Specialization [2] and Baldicer [17] .[1]

Two test instruments were used to measure the impact of the two methods of instruction. The hybrid version of the Test of Understanding in College Economics (Hybrid-TUCE) was used as a pretest, posttest, and retention measure of the students; economic understanding.[2] The Hybrid-TUCE was administered at the beginning and the end of the 1977 Fall semester to measure the students' pre-course and post-course economic knowledge. During the first week of the 1978 Spring semester, which was seven weeks after the completion of the course, the Hybrid-TUCE was administered to measure the students' retention of economic knowledge.

The Questionnaire of Student Attitudes Towards Economics (QSATE) was used as a pretest and posttest measurement of the students' interests

in economics.[3] The QSATE was administered at the beginning and end of the 1977 Fall semester to measure the students' pre-course and post-course interest in economics.

Four additional pieces of data were collected on each student. A student's level of high school economics training was recorded. A student who had at least nine weeks of high school economic instruction was identified as a student who had previous economic instruction. A student's Scholastic Aptitude Test score (SAT) or American College Test score (ACT), which was converted to an SAT score, was used as a measure of the student's scholastic ability. The method of instruction and the instructor to which the student was exposed were also recorded. The nine basic pieces of data that were collected on each student and the additional variables that were generated from these basic pieces of data were listed in Table 1.

Insert Table 1 about here

Multiple linear regression models were constructed to analyze the impact of the methods of instruction on the students' post-course and retention of economic knowledge and post-course interests in economics. A regression model was constructed for each research hypothesis and each null hypothesis. A regression model, which was identified as the full regression model, was designed to depict the conditions stated in the research hypothesis. In a similar fashion, a regression model, which was identified as the restricted regression model, was designed to

reflect the situation depicted in the null hypothesis.[4] The results of the F-tests conducted on the R^2 values of the restricted and full regression models were used to test the hypotheses contained in the study.[5]

Test Results

The results of the Hybrid-TUCE and QSATE tests were listed in Table 2. The dependent t-test results indicated that the students' post-course economic knowledge and retention of economic knowledge were significantly higher than their pre-course economic knowledge. The average percentage increases in the students' economic knowledge between the beginning and end of the course were 53 percent and 51 percent for the control and experimental groups, respectively. The average percentage decreases in the students' economic knowledge between the end of the course and seven weeks after the completion of the course were only 2 percent and 3 percent for the control and experimental groups, respectively. The dependent t-test conducted on the QSATE scores indicated that the students' post-course interests in economics significantly increased during the course.

Insert Table 2 about here

Post-Course Economic Knowledge

Hypothesis $1H_1$, which was stated in Table 3, was designed to determine if a significant interaction existed between the methods of instruction and the students' pre-course economic knowledge when accounting for the

variation in the students' post-course economic knowledge. The values resulting from the analysis of the data examined by Hypothesis $1H_1$ were presented in Table 3.

Insert Table 3 about here

The interaction effect examined in Hypothesis $1H_1$ accounted for 5.7 percent of the variation in the students' post-course economic knowledge. The 5.7 percent of explained variation in the students' post-course economic knowledge produced an F-value of 7.56. The F-value of 7.56 was significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the students' pre-course economic knowledge did account for a statistically significant amount of the variation in the students' post-course economic knowledge.

A graph of the statistically significant interaction that existed between the methods of instruction and the students' pre-course economic knowledge when accounting for the variation in the students' post-course economic knowledge was presented in Figure 1. The graph presented in Figure 1 was obtained by plotting the regression weights of the independent variables of the full regression model used to test Hypothesis $1H_1$. The y-intercept values for the control and experimental groups corresponded to the values of a_0 plus a_1 (5.91) and a_0 plus a_2 (13.02), respectively. The slopes of the lines for the control and experimental groups corresponded to the values of a_{10} (.92) and a_{11} (.17), respectively.

Insert Figure 1 about here

An examination of the graph of the interaction effect presented in Figure 1 indicated that the interaction effect was disordinal. The simultaneous solution of the full and restricted regression models revealed an important result. The students assigned to the experimental classes who had pre-course Hybrid-TUCE below 9.5 points, which was slightly below the average pre-course scores of the four course sections, generally received higher post-course Hybrid-TUCE scores than did their counterparts who were assigned to the control classes. However, the students assigned to the control classes who had pre-course Hybrid-TUCE scores above 9.5 points tended to record higher post-course Hybrid-TUCE scores than did their counterparts who were assigned to the experimental classes.

Hypothesis $2H_1$ was posed to determine if a statistically significant interaction existed between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course economic knowledge. The values resulting from the analysis of the data tested by Hypothesis $2H_1$ were presented in Table 4.

Only 2.5 percent of the variation in the students' post-course economic knowledge was accounted for by the interaction effect examined in Hypothesis $2H_1$. The resulting F-value of 1.99 was not significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the students' scholastic abilities did not

account for a statistically significant amount of the variation in the students' post-course economic knowledge.

Insert Table 4 about here

Hypothesis $3H_1$ was designed to test for the existence of a statistically significant interaction between the methods of instruction and the students' previous economic training when accounting for the variation in the students' post-course economic knowledge. The values produced from the analysis of the data examined in Hypothesis $3H_1$ were presented in Table 5.

The interaction effect examined in Hypothesis $3H_1$ explained 4.4 percent of the variation in the students' post-course economic knowledge. The corresponding F-value of 5.05 was significant at the predetermined alpha level of .05. Thus, the interaction between the methods of instruction and the students' previous economic training did account for a statistically significant amount of the variation in the students' post-course economic knowledge.

Insert Table 5 about here

A graph of the significant interaction effect that existed between the methods of instruction and the students' previous economic training when accounting for the variation in the students' post-course economic

knowledge was presented in Figure 2. The graph presented in Figure 2 was obtained by plotting the regression weights of the independent variables of the full regression model used to test Hypothesis $3H_1$. These regression weights represented the adjusted mean post-course Hybrid-TUCE scores for the four groups of students examined. The adjusted mean score for the students in the control classes who had previous economic training ($a_0 + a_{14}$) was 15.89 points. The adjusted mean score for their counterparts in the experimental classes ($a_0 + a_{16}$) was 13.12 points. The adjusted mean score for the students in the control classes who did not have previous economic training ($a_0 + a_{15}$) was 14.27 points. Their counterparts in the experimental classes had an adjusted mean score ($a_0 + a_{17}$) of 15.33 points.

An investigation of the graph presented in Figure 2 revealed that the interaction effect was disordinal. A further examination of the disordinal interaction effect indicated that the students with no previous economic training who were enrolled in the experimental classes had a higher average post-course Hybrid-TUCE score than did their counterparts who were enrolled in the control classes. However, the students with previous economic training who were enrolled in the control classes had a higher average post-course Hybrid-TUCE score than did their counterparts who were enrolled in the control classes.

Insert Figure 2 about here

Hypothesis $4H_1$ was posed to determine if a statistically significant interaction existed between the methods of instruction and the teachers

when accounting for the variation in the students' post-course economic knowledge. The values produced from the analysis of the data tested by Hypothesis $4H_1$ were presented in Table 6.

Insert Table 6 about here

Only .1 percent of the total variation in the students' post-course economic knowledge was accounted for by the interaction effect examined in Hypothesis $4H_1$. The resulting F-value of .11 was not significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the teachers did not account for a statistically significant amount of variation in the students' post-course economic knowledge.

A fifth hypothesis was posed to determine if a statistically significant difference existed between the methods of instruction with respect to the students' levels of post-course economic knowledge over and above the differences due to the teachers and the students' pre-course economic knowledge, scholastic abilities, and previous economic training. However, prior to the testing of Hypothesis $5H_1$, the homogeneity of the regression slopes of the covariates had to be established. That is, if Hypothesis $5H_1$ was to be tested, statistically significant interaction effects could not have existed between the methods of instruction and the four covariates used in Hypothesis $5H_1$. These four covariates were the teachers, the students' pre-course economic knowledge, scholastic abilities and previous economic training.

As indicated by the results of F-tests for Hypothesis $1H_1$ and Hypothesis $3H_1$, the assumption of homogeneous regression slopes of the covariates in Hypothesis $5H_1$ was violated. Therefore, it would have been inappropriate to test Hypothesis $5H_1$. A statement could not be made concerning the superior ability of one method of instruction to increase the students' post-course economic knowledge without consideration being given to the students' pre-course economic knowledge and previous economic training.

Retention of Economic Knowledge

Hypothesis $6H_1$ was included in the study to determine if a significant interaction effect existed between the students' pre-course economic knowledge and the methods of instruction when accounting for the variation in the students' retention of economic knowledge. The values obtained through the analysis of Hypothesis $6H_1$ were listed in Table 7.

The interaction effect examined in Hypothesis $6H_1$ explained 5.5 percent of the variation in the students' retention of economic knowledge. The F-value of 6.38, which was calculated for Hypothesis $6H_1$, was statistically significant at the predetermined alpha level of .05. Thus, the interaction between the students' pre-course economic knowledge and the methods of instruction did explain a statistically significant amount of the variation in the students' retention of economic knowledge.

Insert Table 7 about here

A graph of the significant interaction that existed between the students' pre-course economic knowledge and the methods of instruction when accounting for the variation in the students' retention of economic knowledge was presented in Figure 3. The graph presented in Figure 3 was obtained by plotting the regression weights of the independent variables of the full regression model used to test Hypothesis $6H_1$. The y-intercept values for the control and experimental groups corresponded to the values for a_1 plus a_0 (4.85) and a_2 plus a_0 (11.76), respectively. The slopes of the lines for the control and experimental groups corresponded to the values for a_{12} (1.01) and a_{11} (.28), respectively.

Insert Figure 3 about here

An examination of the graph presented in Figure 3 indicated that the interaction effect was disordinal. Further analysis of this disordinal interaction effect revealed that the students in the experimental classes who had pre-course Hybrid-TUCE scores lower than 9.4 points tended to receive higher delayed-interval Hybrid-TUCE scores than did their counterparts who were assigned to the control classes. However, the students in the control classes who had pre-course Hybrid-TUCE scores higher than 9.4 points generally received higher delayed-interval Hybrid-TUCE scores than did their counterparts who were assigned to the experimental classes.

Hypothesis $7H_1$ was posed to determine if a statistically significant interaction existed between the methods of instruction and the students'

scholastic abilities when accounting for the variation in the students' retention of economic knowledge. The values produced by the analysis of Hypothesis $7H_1$ were listed in Table 8.

The interaction between the methods of instruction and the students' scholastic abilities accounted for 4.6 percent of the variation in the students' retention of economic knowledge. The corresponding F-value of 4.46 was significant at the predetermined alpha level of .05. Thus, the interaction between the methods of instruction and the students' scholastic abilities did account for a statistically significant amount of variation in the students' retention of economic knowledge.

Insert Table 8 about here

A graph of the interaction effect examined in Hypothesis $7H_1$ was presented in Figure 4. The graph presented in Figure 4 was obtained by plotting the regression weights of the independent values of the full regression model used to test Hypothesis $7H_1$. The y-intercept values for the control and experimental groups corresponded to a_0 plus a_1 (-.02) and a_0 plus a_2 (7.94), respectively. The slopes of the lines for the control and experimental groups corresponded to a_{12} (.0178) and a_{13} (.0079), respectively.

An examination of the graph presented in Figure 4 indicated that the interaction effect was disordinal. Further analysis of the disordinal interaction effect indicated that the students with SAT scores below 802

points who were assigned to the experimental classes received higher delayed-interval Hybrid-TUCE scores than did their counterparts who were assigned to the control classes. However, the students with SAT scores above 802 points and who were assigned to the control classes received higher delayed-interval Hybrid-TUCE scores than did their counterparts who were assigned to the experimental classes.

Insert Figure 4 about here

Hypothesis $8H_1$ was designed to determine if a statistically significant interaction existed between the method of instruction and the students' previous economic training when accounting for the variation in the students' retention of economic knowledge. The values obtained from the analysis of Hypothesis $8H_1$ were presented in Table 9.

Less than .4 percent of the variation in the students' retention of economic knowledge was accounted for by the interaction between the methods of instruction and the students' previous economic training. The corresponding F-value of .35 was not statistically significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the students' previous economic training did not account for a statistically significant amount of the variation in the students' retention of economic knowledge.

Insert Table 9 about here

Hypothesis $9H_1$ was designed to determine if a significant interaction existed between the methods of instruction and the teachers when accounting for the variation in the students' retention of economic knowledge. The values obtained from the analysis of Hypothesis $9H_1$ were listed in Table 10.

Only .9 percent of the variation in the students' retention of economic knowledge was explained by the interaction between the methods of instruction and the teachers. The corresponding F-value of .85 was not significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the teachers did not account for a statistically significant amount of the variation in the students' retention of economic knowledge.

Insert Table 10 about here

A tenth hypothesis was posed to determine if a statistically significant difference existed between the methods of instruction with respect to the students' retention of economic knowledge. Before Hypothesis $10H_1$ could be tested, however, the homogeneity of the regression slopes of the coveriates had to be established. That is, if Hypothesis $10H_1$ was to be tested, statistically significant interaction effects could not have existed between the methods of instruction and the four covariates used in Hypothesis $10H_1$. These four covariates were the teachers and the students' pre-course economic knowledge, scholastic abilities, and previous economic training.

The F-test results for Hypothesis $6H_1$ and Hypothesis $7H_1$ indicated that the assumption concerning the homogeneous regression slopes of the covariates contained in Hypothesis $10H_1$ was violated. Therefore, it would have been inappropriate to test Hypothesis $10H_1$. A statement could not be made concerning the superior ability of one method of instruction to increase the students' retention of economic knowledge without consideration being given to the students' pre-course economic knowledge and scholastic abilities.

Post-Course Interest in Economics

Hypothesis $11H_1$ was designed to test for the existence of a statistically significant interaction between the methods of instruction and the students' pre-course interests in economics when accounting for the variance in the students' post-course interests in economics. The values resulting from the analysis of the data tested by Hypothesis $11H_1$ were presented in Table 11.

Only .3 percent of the variation in the students' post-course interests in economics was explained by the interaction between the methods of instruction and the students' pre-course interests in economics. The F-value of .36, which was calculated for Hypothesis $11H_1$, was not statistically significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the students' pre-course interests in economics did not account for a statistically significant amount of the variation in the students' post-course interests in economics.

Insert Table 11 about here

Hypothesis $12H_1$ was posed to test for the existence of a significant interaction between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course interests in economics. The values procuded from the analysis of the data tested by Hypothesis $12H_1$ were presented in Table 12.

The interaction effect examined in Hypothesis $12H_1$ accounted for 3.6 percent of the total variation in the students' post-course interests in economics. The resulting F-value for Hypothesis $12H_1$ was 4.19. This F-value of 4.19 was significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the students' scholastic abilities did account for a statistically significant amount of variation in the students' post-course interests in economics.

Insert Table 12 about here

A graph of the statistically significant interaction that existed between the methods of instruction and the students' scholastic abilities when accounting for the students' post-course interests in economics was presented in Figure 5. The graph presented in Figure 5 was obtained by plotting the regression weights of the independent variables of the full

regression model used to test Hypothesis $12H_1$. The y-intercept values for the control and experimental groups corresponded to a_0 plus a_1 (24.88) and a_0 plus a_2 (31.64), respectively. The slopes for the control and experimental groups corresponded to a_{12} (.00896) and a_{13} (-.00086), respectively.

Insert Figure 5 about here

As indicated by the graph in Figure 5 the interaction effect that existed between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course interests in economics was disordinal. The experimental method of instruction was more effective than the control method with respect to increasing the students' post-course interests in economics for the students with SAT scores below 686 points. However, the control method of instruction was more effective than the experimental method of instruction with respect to increasing the students' post-course interests in economics for the students with SAT scores above 686 points.

Hypothesis $13H_1$ was designed to test for the existence of a statistically significant interaction between the methods of instruction and the students' previous economic training when accounting for the variation in the students' post-course interests in economics. The values produced

by the analysis of the data tested by Hypothesis $13H_1$ were presented in Table 13.

Less than .1 percent of the variation in the students' post-course interests in economics was accounted for by the interaction effect examined by Hypothesis $13H_1$. The resulting F-value of .01 was not significant at the predetermined alpha level of .05. Therefore, the interaction effect between the methods of instruction and the students' previous economic training did not account for a statistically significant amount of the variation in the students' post-course interests in economics.

Insert Table 13 about here

Hypothesis $14H_1$ was posed to determine if a statistically significant interaction existed between the methods of instruction and the teachers when accounting for the variation in the students' post-course interests in economics. The values that were used in the testing of Hypothesis $14H_1$ were presented in Table 14.

The interaction effect investigated by Hypothesis $14H_1$ accounted for only .1 percent of the variation in the students' post-course interests in economics. The resulting F-value of .12 was not significant at the predetermined alpha level of .05. Therefore, the interaction between the methods of instruction and the teachers did not account for a statistically significant amount of the variation in the students' post-course interests in economics.

Insert Table 14 about here

A fifteenth hypothesis was included in this study to determine if a statistically significant difference existed between the methods of instruction with respect to the students' levels of post-course interest in economics. However, the homogeneity of the regression slopes of the four covariates had to be established before Hypothesis $15H_1$ could be tested. The four covariates were the teachers and the students' pre-course interests in economics, scholastic abilities and previous economic training.

The significant interaction effect that existed between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course interests in economics violated the assumption concerning the homogeneity of regression slopes of the covariates. Therefore, it was inappropriate to test Hypothesis $15H_1$. A statement could not be made concerning the superior ability of one method of instruction to increase the students' interests in economics without consideration being given to the students' scholastic abilities.

Conclusions

The results of this study indicated that neither the simulation-gaming method of instruction nor the lecture-discussion method of instruction could be declared superior. The relative effectiveness of each method of instruction was dependent on certain student characteristics. The impact of certain student characteristics on the relative effectiveness of the methods of instruction revealed important relationships that should be known by college instructors and administrators.

First, a pre-course measurement of the students' economic knowledge may be desirable. This study suggested that students with low pre-course knowledge would attain higher levels of post-course economic knowledge and retention of economic knowledge when assigned to a course section taught by the simulation-gaming method. The students with high pre-course knowledge would tend to attain higher levels of post-course economic knowledge and retention of economic knowledge when assigned to a course section taught by the lecture-discussion method.

Second, an examination of the students' transcripts or a survey of the students may be desirable to determine if they have had previous economic instruction. Students with ~~no~~ out previous economic training tended to achieve higher levels of post-course economic knowledge when taught by the simulation-gaming method. Students with previous economic training tended to achieve higher levels of post-course economic knowledge when assigned to a section taught by the lecture-discussion method.

Finally, the students' SAT scores may be useful to college instructors and college administrators when advising or assigning students to

introductory economics courses. Students with low SAT scores expressed higher levels of post-course interests in economics and retained more economic knowledge when instructed by the simulation-gaming method. However, the students with high SAT scores expressed higher levels of post-course interest in economics and retained more economic knowledge when instructed by the lecture-discussion method. In the opinion of this researcher, the criteria established in this study to place the students in the course sections that would most improve the students' retention of economic knowledge should be given consideration over the SAT guidelines used to assign students to the sections that would most improve their post-course interests in economics.

NOTES

1. A detailed description of the methods of instruction can be found in Chapter III of the doctoral thesis by J. Fraas (1).

2. KR-20 reliability estimates of the Hybrid-TUCE, which ranged from .66 to .82, were reported by Saunders and Bach (11). An estimate of the known-group validity of the Hybrid-TUCE used in conjunction with the introductory economics class at Ashland College was made by Fraas (1). The coefficient of validity was equal to .558.

3. Reliability of the QSATE was examined by Karstensson (6). The split-half reliability estimates for the QSATE used as a pretest and post-test were .88 and .93, respectively. Results of a study conducted by Karstensson and Vedder (7) led the authors to conclude that the QSATE was a valid instrument to measure students' interests in economics.

4. The regression analyses were performed by the computer program DPLINEAR. (8). This computer program utilizes an iteration process to find the least squares coefficients. The program requires both treatment variables to be included in the regression model even though they are linearly dependent variables. The computer automatically assigns a value of zero to one of the treatment variables.

5. The F-value for each hypothesis was calculated by the following formula:

$$F = \frac{(R_F^2 - R_R^2) \,/\, (m_1 - m_2)}{(1 - R_F^2) \,/\, (N - m_1)}$$

R_F^2 and R_R^2 represented the total variance in the criterion variable that was accounted for by the variation in the predictor variables in the full and restricted regression models, respectively. The symbols m_1 and m_2 represented the number of linearly independent vectors in the full and restricted regression models, respectively. N represented the number of students being examined by the given hypothesis.

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Table 1. A DESCRIPTION OF THE VARIABLES UTILIZED IN THE STUDY

Variables	Description of the Variables
Y_1	Post-course economic knowledge (Post-course Hybrid-TUCE score, 0-33)
Y_2	Retention of economic knowledge (Delayed-Interval Hybrid TUCE score, 0-33)
Y_3	Post-course interests in economics (Post-course QSATE score, 8-40)
X_1	Students exposed to the lecture-discussion method (yes = 1 ; no = 0)
X_2	Students exposed to the simulation-gaming method (yes = 1 ; no = 0)
X_3	Pre-course economic knowledge (Pre-course Hybrid-TUCE score, 0-33)
X_4	Pre-course interest in economics (Pre-course QSATE score, 8-40)
X_5	Scholastic Ability (SAT score, 400-1600)
X_6	Students with high school economic instruction (yes = 1 ; no = 0)
X_7	Students without high school economic instruction (yes = 1 ; no = 0)
X_8	Teacher A (yes = 1 ; no = 0)
X_9	Teacher B (yes = 1 ; no = 0)
X_{10}	The pre-course Hybrid TUCE scores of the students exposed to the lecture-discussion method ($X_1 \cdot X_3$)
X_{11}	The pre-course Hybrid TUCE scores of the students exposed to the simulation-gaming method ($X_2 \cdot X_3$)

Table 1 (continued)

X_{12}	The SAT scores of the students exposed to the lecture-discussion method ($X_1 \cdot X_5$)
X_{13}	The SAT scores of the students exposed to the simulation-gaming method ($X_2 \cdot X_5$)
X_{14}	The students with previous economic training who were exposed to the lecture-discussion method ($X_1 \cdot X_6$)
X_{15}	The students with no previous economic training who were exposed to the lecture-discussion method ($X_1 \cdot X_7$)
X_{16}	The students with previous economic training who were exposed to the simulation-gaming method ($X_2 \cdot X_6$)
X_{17}	The students with no previous economic training who were exposed to the simulation-gaming method ($X_2 \cdot X_7$)
X_{18}	Students exposed to Teacher A and the lecture-discussion method of instruction ($X_1 \cdot X_8$)
X_{19}	Students exposed to Teacher A and the simulation-gaming method of instruction ($X_2 \cdot X_8$)
X_{20}	Students exposed to Teacher B and the lecture-discussion method of instruction ($X_1 \cdot X_9$)
X_{21}	Students exposed to Teacher B and the simulation-gaming method of instruction ($X_2 \cdot X_9$)
X_{22}	Pre-course QSATE scores for students exposed to the lecture-discussion method ($X_1 \cdot X_4$)
X_{23}	Pre-course QSATE scores for students exposed to the simulation-gaming method ($X_2 \cdot X_4$)

Table 2. DESCRIPTION OF THE TEST RESULTS

	Test Results				
	Pre-Course Hybrid-TUCE		Post-Course Hybrid-TUCE		
	$\bar{X}$	SD	$\bar{X}$	SD	t-value
Control $n = 56$	9.67	2.78	14.82	4.52	10.35[a]
Experimental $n = 56$	9.75	2.73	14.70	3.90	8.30[a]
	Pre-Course QSATE		Post-Course QSATE		
	$\bar{X}$	SD	$\bar{X}$	SD	
Control $n = 56$	29.88	3.07	32.32	4.04	3.87[a]
Experimental $n = 56$	28.80	3.10	30.98	5.04	2.97[a]
	Pre-Course Hybrid-TUCE		Delayed-Interval Hybrid-TUCE		
	$\bar{X}$	SD	$\bar{X}$	SD	
Control $n = 44$	9.75	2.91	14.89	4.79	9.01[a]
Experimental $n = 48$	9.69	2.81	14.52	3.91	8.39[a]

[a]Significant at the .01 level

Table 3. TEST RESULTS FOR HYPOTHESIS $1H_1$

Hypothesis $1H_1$	There was a significant interaction between the methods of instruction and the students' pre-course economic knowledge when accounting for the variation in the students' post-course economic knowledge over and above the differences due to the students' pre-course economic knowledge and the methods of instruction.
Full Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_{10}X_{10} + a_{11}X_{11} + E_1$
Restriction:	$a_{10} = a_{11}$
Restricted Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_3X_3 + E_2$
Full Model $\underline{R}^2$	.191
Restricted Model $\underline{R}^2$	.134
$\underline{df}$	1/108
$\underline{F}$	7.56
$\underline{p}$	.007[a]

[a]Significant at the predetermined alpha level of .05

Table 4. TEST RESULTS FOR HYPOTHESIS $2H_1$

Hypothesis $2H_1$	There was a significant interaction between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course economic knowledge over and above the differences due to the students' scholastic abilities and the method of instruction.
Full Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_{12}X_{12} + a_{13}X_{13} + E_3$
Restriction:	$a_{12} = a_{13}$
Restricted Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_5X_5 + E_4$
Full Model $\underline{R}^2$	.236
Restricted Model $\underline{R}^2$	.221
$\underline{df}$	1/108
$\underline{F}$	1.99
$\underline{p}$	.161[a]

[a]Not significant at the predetermined alpha level of .05

Table 5. TEST RESULTS FOR HYPOTHESIS $3H_1$

Hypothesis $3H_1$	There was a significant interaction between the methods of instruction and the students' previous economic training when accounting for the variation in the students' post-course economic knowledge over and above the differences due to the students' previous economic training and the methods of instruction.
Full Model:	$Y_1 = a_0U + a_{14}X_{14} + a_{15}X_{15} + a_{16}X_{16} + a_{17}X_{17} + E_5$
Restriction:	$a_{14} - a_{16} = a_{15} - a_{17}$
Restricted Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_6X_6 + a_7X_7 + E_6$
Full Model $\underline{R}^2$	.045
Restricted Model $\underline{R}^2$	.001
$\underline{df}$	1/108
$\underline{F}$	5.05
$\underline{p}$	.027

[a]Significant at the predetermined alpha level of .05

Table 6. TEST RESULTS FOR HYPOTHESIS $4H_1$

Hypothesis $4H_1$	There was a significant interaction between the methods of instruction and the teachers when accounting for the variation in the students' post-course economic knowledge over and above the differences due to the methods of instruction and the teachers.
Full Model:	$Y_1 = a_0U + a_{18}X_{18} + a_{19}X_{19} + a_{20}X_{20} + a_{21}X_{21} + E_7$
Restriction:	$a_{18} - a_{19} = a_{20} - a_{21}$
Restricted Model:	$Y_1 = a_0U + a_1X_1 + a_2X_2 + a_8X_8 + a_9X_9 + E_8$
Full Model $\underline{R}^2$	.064
Restricted Model $\underline{R}^2$	.063
$\underline{df}$	1/108
$\underline{F}$	.11
$\underline{p}$	.743

[a]Not significant at the predetermined alpha level of .05

Table 7. TEST RESULTS FOR HYPOTHESIS $6H_1$

Hypothesis $6H_1$	There was a significant interaction between the methods of instruction and the students' pre-course economic knowledge when accounting for the variation in the students' retention of economic knowledge over and above the differences due to the students' pre-course economic knowledge and the methods of instruction.
Full Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_{10}X_{10} + a_{11}X_{11} + E_9$
Restriction:	$a_{10} = a_{11}$
Restricted Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_3X_3 + E_{10}$
Full Model $\underline{R}^2$	.241
Restricted Model $\underline{R}^2$	.186
$\underline{df}$	1/88
$\underline{F}$	6.38
$\underline{p}$	.013[a]

[a]Significant at the predetermined alpha level of .05

Table 8. TEST RESULTS FOR HYPOTHESIS $7H_1$

Hypothesis $7H_1$	There was a significant interaction between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' retention of economic knowledge over and above the differences due to the students' scholastic abilities and the methods of instruction.
Full Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_{12}X_{12} + a_{13}X_{13} + E_{11}$
Restriction:	$a_{12} = a_{13}$
Restricted Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_5X_5 + E_{12}$
Full Model $\underline{R}^2$	.290
Restricted $\underline{R}^2$	.244
$\underline{df}$	1/88
$\underline{F}$	5.75
$\underline{p}$	.019[a]

[a]Significant at the predetermined alpha level of .05

Table 9. TEST RESULTS FOR HYPOTHESIS $8H_1$

Hypothesis $8H_1$	There was a significant interaction between the methods of instruction and the students' previous economic training when accounting for the variation in the students' retention of economic knowledge over and above the differences due to the students' previous economic training and the methods of instruction.
Full Model:	$Y_2 = a_0U + a_{14}X_{14} + a_{15}X_{15} + a_{16}X_{16} + a_{17}X_{17} + E_{13}$
Restriction:	$a_{14} - a_{16} = a_{15} - a_{17}$
Restricted Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_6X_6 + a_7X_7 + E_{14}$
Full Model $\underline{R}^2$	.007
Restricted Model $\underline{R}^2$	.003
$\underline{df}$	1/88
$\underline{F}$	.35
$\underline{p}$	.553[a]

[a]Not significant at the predetermined alpha level of .05

Table 10. TEST RESULTS FOR HYPOTHESIS $9H_1$

Hypothesis $9H_1$	There was a significant interaction between the methods of instruction and the teachers when accounting for the variation in the students' retention of economic knowledge over and above the differences due to the teachers and the methods of instruction.
Full Model:	$Y_2 = a_0U + a_{18}X_{18} + a_{19}X_{19} + a_{20}X_{20} + a_{21}X_{21} + E_{15}$
Restriction:	$a_{18} - a_{19} = a_{20} - a_{21}$
Restricted Model:	$Y_2 = a_0U + a_1X_1 + a_2X_2 + a_8X_8 + a_9X_9 + E_{16}$
Full Model $\underline{R}^2$	.057
Restricted Model $\underline{R}^2$	.048
$\underline{df}$	1/88
$\underline{F}$	.85
$\underline{p}$	.358[a]

[a]Not significant at the predetermined alpha level of .05

Table 11. TEST RESULTS FOR HYPOTHESIS $11H_1$

Hypothesis $11H_1$	There was a significant interaction between the methods of instruction and the students' pre-course interests towards economics when accounting for the variation in the students' post-course interests interests in economics over and above the differences due to the students' pre-course interests in economics and the method of instruction.
Full Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_{22}X_{22} + a_{23}X_{23} + E_{17}$
Restriction:	$a_{22} = a_{23}$
Restricted Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_4X_4 + E_{18}$
Full Model $\underline{R}^2$	.058
Restricted Model $\underline{R}^2$	.055
$\underline{df}$	1/108
$\underline{F}$	.36
$\underline{P}$	.548[a]

[a]Not significant at the predetermined alpha level of .05

Table 12. TEST RESULTS FOR HYPOTHESIS $12H_1$

Hypothesis $12H_1$	There was a significant interaction between the methods of instruction and the students' scholastic abilities when accounting for the variation in the students' post-course interests in economics over and above the differences due to the students' scholastic abilities and the methods of instruction.
Full Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_{12}X_{12} + a_{13}X_{13} + E_{19}$
Restriction:	$a_{12} = a_{13}$
Restricted Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_5X_5 + E_{20}$
Full Model $\underline{R}^2$	.071
Restricted Model $\underline{R}^2$	.035
$\underline{df}$	1/108
$\underline{F}$	4.19
$\underline{p}$	.043[a]

[a]Significant at the predetermined alpha level of .05

Table 13. TEST RESULTS FOR HYPOTHESIS $13H_1$

Hypothesis $13H_1$	There was a significant interaction between the methods of instruction and the students' previous economic training when accounting for the variation in the students' post-course interests in economics over and above the differences due to the students' previous economic training and the methods of instruction.
Full Model:	$Y_3 = a_0U + a_{14}X_{14} + a_{15}X_{15} + a_{16}X_{16} + a_{17}X_{17} + E_{21}$
Restriction:	$a_{14} - a_{16} = a_{15} - a_{17}$
Restricted Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_6X_6 + a_7X_7 + E_{22}$
Full Model $\underline{R}^2$	.027
Restricted Model $\underline{R}^2$	.027
$\underline{df}$	1/108
$\underline{F}$	.01
$\underline{p}$	.95[a]

[a]Not significant at the predetermined alpha level of .05

Table 14. TEST RESULTS OF HYPOTHESIS $14H_1$

Hypothesis $14H_1$	There was a significant interaction between the methods of instruction and the teachers when accounting for the variation in the students' post-course interests in economics over and above the differences due to the teachers and the methods of instruction.
Full Model:	$Y_3 = a_0U + a_{18}X_{18} + a_{19}X_{19} + a_{20}X_{20} + a_{21}X_{21} + E_{23}$
Restriction:	$a_{18} - a_{19} = a_{20} - a_{21}$
Restricted Model:	$Y_3 = a_0U + a_1X_1 + a_2X_2 + a_8X_8 + a_9X_9 + E_{24}$
Full Model $\underline{R}^2$	.207
Restricted Model $\underline{R}^2$	.206
$\underline{df}$	1/108
$\underline{F}$	.12
$\underline{p}$	.73[a]

[a]Not significant at the predetermined alpha level of .05

Figure 1. PRE-COURSE HYBRID-TUCE SCORES BY TREATMENT INTERACTION IN RELATION TO POST-COURSE HYBRID-TUCE SCORES.

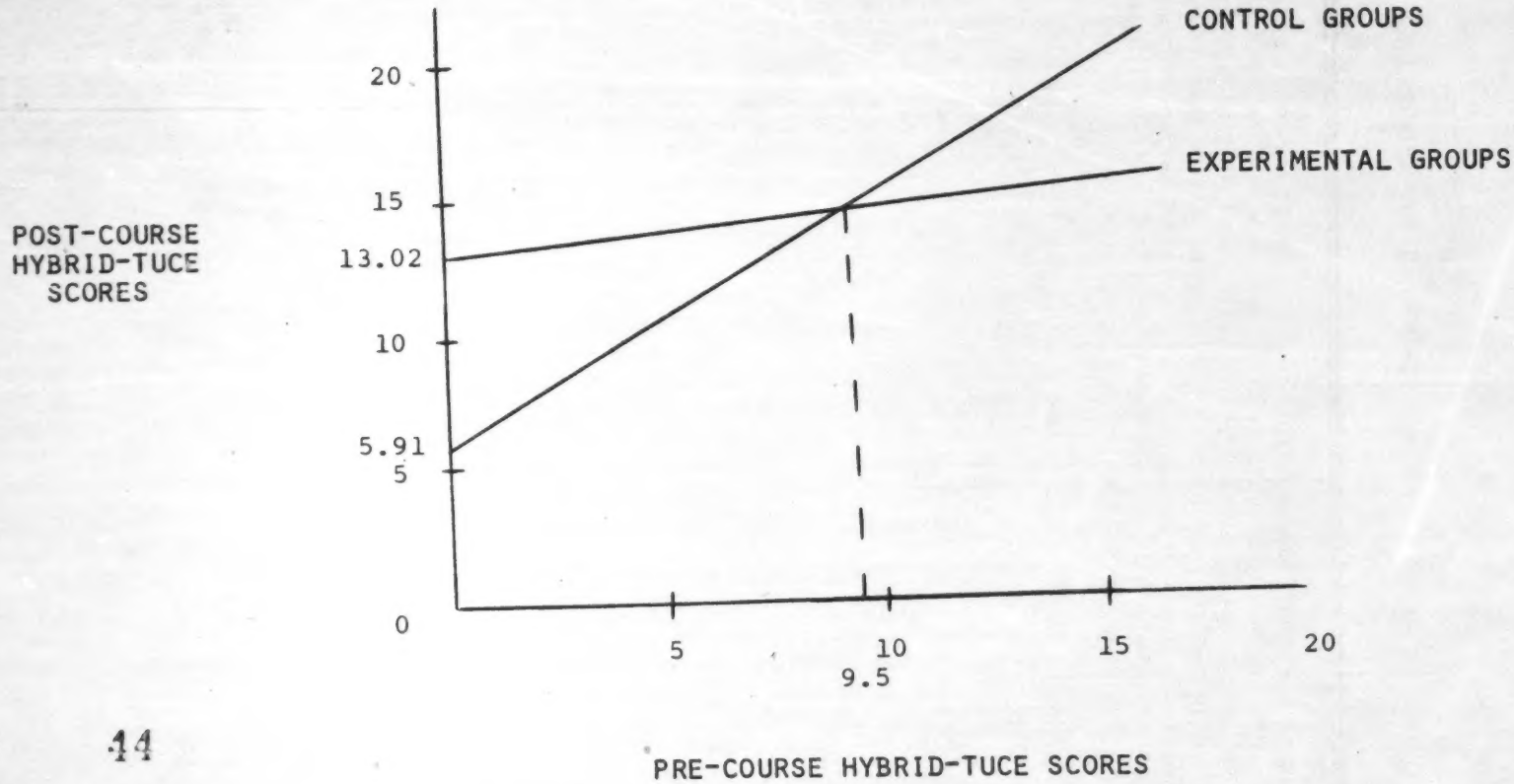

Figure 2. ECONOMIC TRAINING BY TREATMENT INTERACTION IN RELATION TO POST-COURSE HYBRID-TUCE SCORES

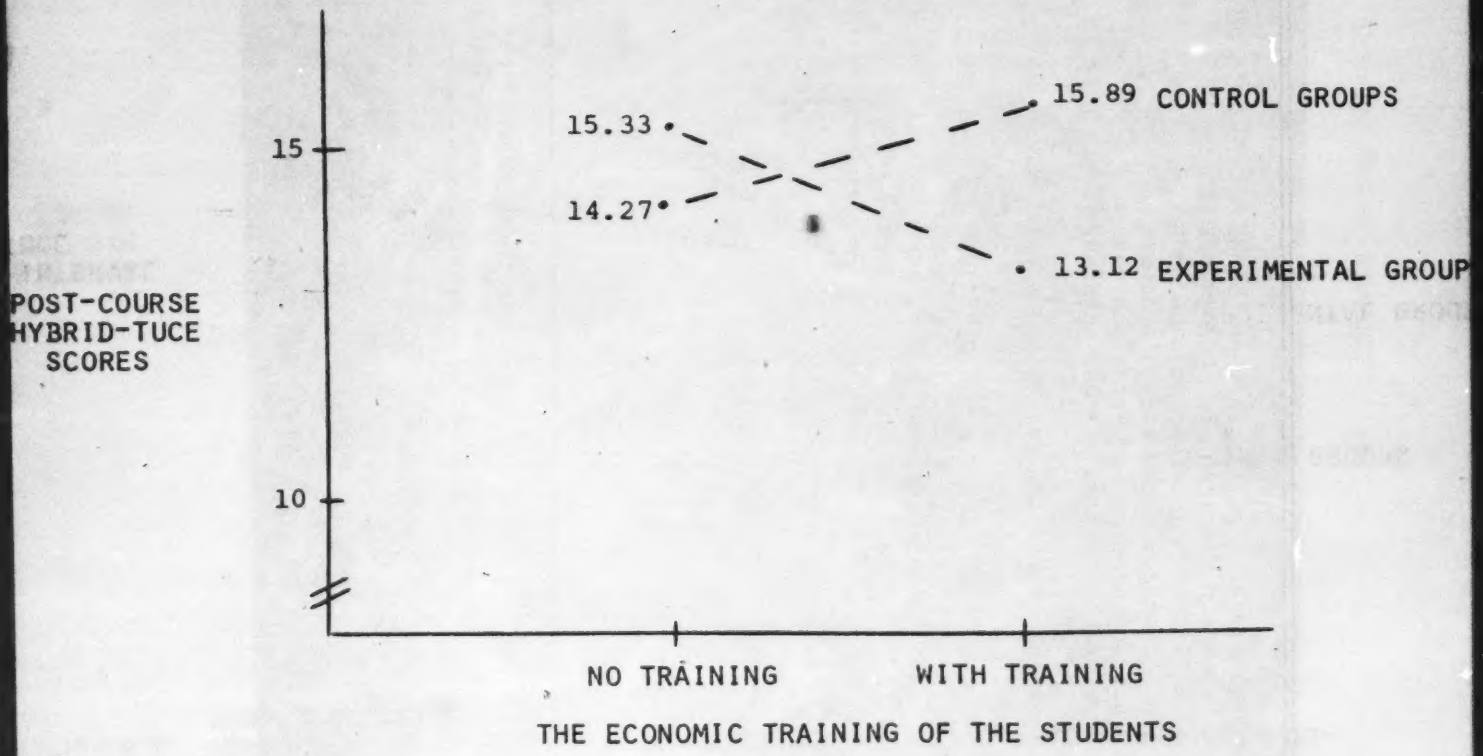

Figure 3. PRE-COURSE HYBRID-TUCE SCORES BY TREATMENT INTERACTION IN RELATION TO DELAYED-INTERVAL HYBRID-TUCE SCORES.

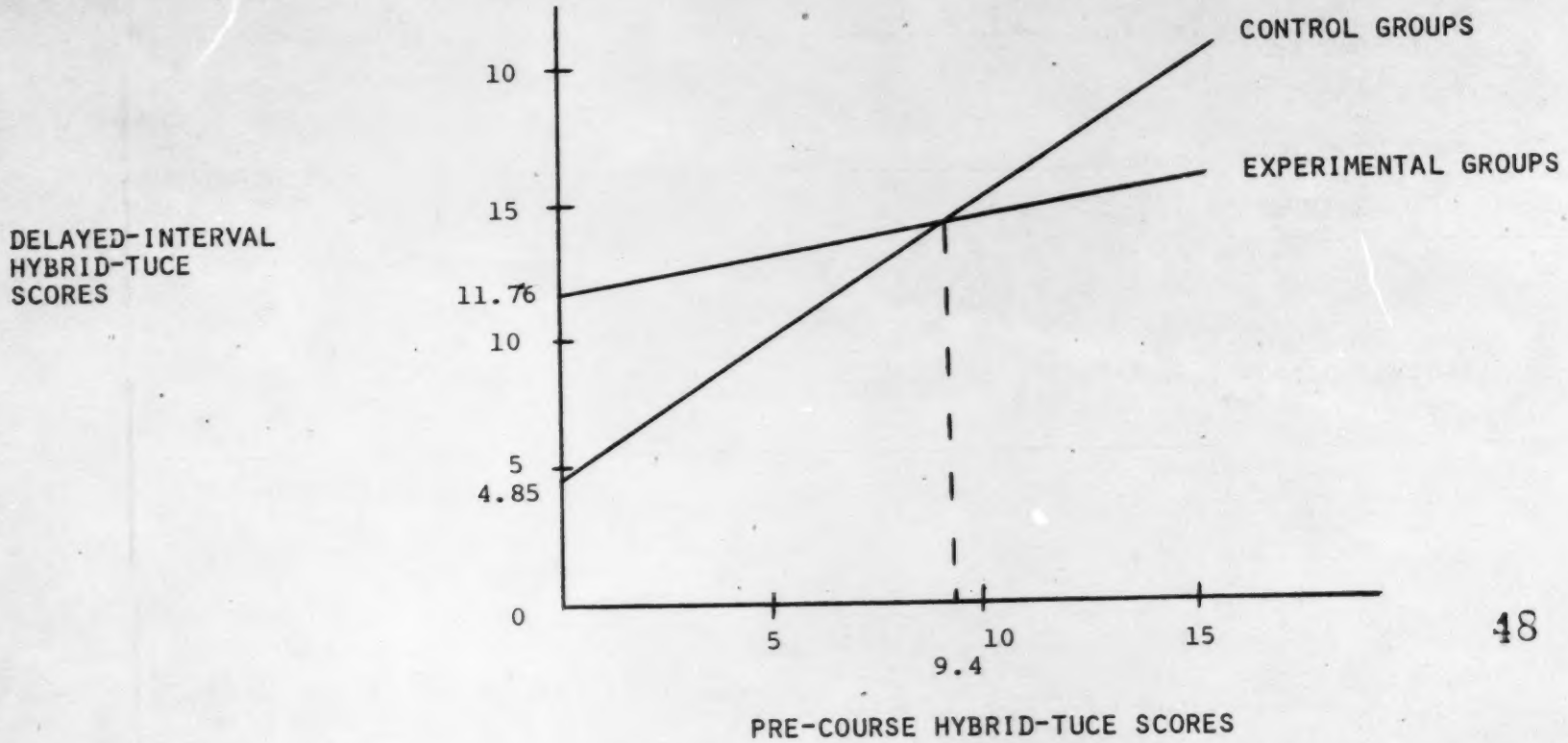

Figure 4. SAT SCORES BY TREATMENT INTERACTION IN RELATION TO DELAYED-INTERVAL HYBRID-TUCE SCORES.

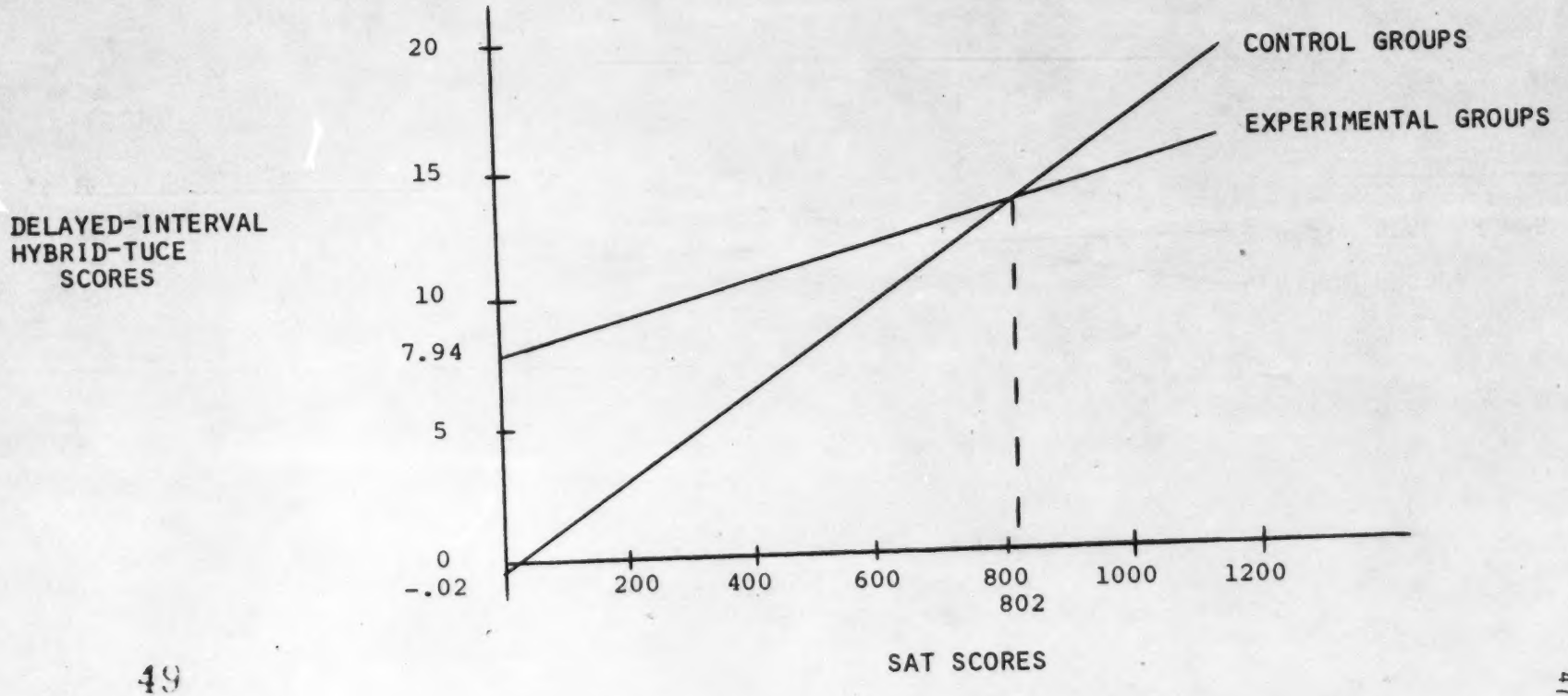

Figure 5. SAT SCORES BY TREATMENT INTERACTION IN RELATION TO POST-COURSE QSATE SCORES.